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Title slide: Analyzing NCES Complex Survey Data

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The objectives of this module are to introduce the design and analysis of NCES data, identify different types of NCES surveys and studies, explain the essentials of sampling and sampling designs used by NCES, and describe how to use sampling weights and design variables to analyze NCES micro-level data.

This module is designed to help you learn about the research methods and statistical techniques that NCES uses to provide high-quality micro-level data. This module also describes the aspects of the NCES study designs that you need to understand in order to conduct your own analyses.

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NCES studies are designed to collect data on a variety of educational topics that are of interest to researchers and policy makers. NCES relies on the processes detailed in the NCES Statistical Standards in order to ensure that the data collected are consistent, reliable, complete, and accurate. NCES monitors and documents the methodologies associated with each dataset. It also analyzes and reports on the data in a variety of products and publications.

NCES sample surveys provide access to nationally representative data that are generalizable to the population and can be used to answer a variety of research questions.

It is possible that the answer to your research question can be found within an existing NCES product, including web tables and published reports, or by using the Data and Tools portion of the NCES website.

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There are limitations associated with using any data, however. Although NCES data were collected to address a range of research questions, your exact research question may not be directly answerable using these data. Additionally, you will need to invest a considerable amount of time and energy reading and learning about the data in order to understand what the data can and cannot tell you and how they may or may not be appropriate for your analytic purposes.

It is your responsibility as a data analyst to thoroughly familiarize yourself with the dataset of interest. This begins with reviewing the studies that are available, selecting the one that you think will best address your research question, reading the documentation associated with that dataset, and then using web tools or obtaining the micro-level data for use in the statistical package of your choice.

NCES provides many resources, such as those listed, to help you gain a thorough understanding of the dataset that best fits your research needs. Becoming acquainted with the NCES datasets will allow you to decide which data will help you efficiently and effectively meet your research needs. You will have to make decisions that depend on your interests, prior research, computer resources, available data, and other factors when selecting and then using NCES data for analysis.

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It is important to understand the NCES data and how to analyze them properly.

It is possible that the answer to your research question can be found within an existing NCES product, including web tables and published reports, or by using the Data and Tools portion of the NCES website.

To facilitate your understanding of the topics presented within the Distance Learning Dataset Training system, or DLDT, we will use a training dataset from the Early Childhood Longitudinal Studies program in Statistical Analysis of NCES Datasets Employing a Complex Sample Design. Therefore, let’s take a few minutes to become familiar with the types of publications, products, and other NCES provided resources available within each survey program and their studies.

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There are two types of NCES surveys: universe surveys and sample surveys. There are different considerations associated with these surveys.

Universe collections are sometimes referred to as a population survey or census. Universe surveys gather data from all units in a population of interest and have several advantages. Since all units are observed, there is no sampling error and thus no need to account for it. Specifically, this means observed differences or trends are real differences or trends, and changes over time are treated as real changes. Additionally, because NCES universe surveys often collect data from administrative or official records, the data are typically aggregates of data about individuals and more accurate.

However universe surveys can be resource-intensive. When the population is large, they require adequate time to collect data from the contacts. Also, the data that are collected are sometimes less detailed because of resource constraints. Thus, it is often not feasible to use a universe survey to collect much of the data in which researchers are interested.

Examples of universe surveys at NCES are the Common Core of Data, the Private School Universe Survey, and the Integrated Postsecondary Education Data System.

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Sample surveys gather information from a sample of the population of interest. Sample surveys can be more cost-effective compared to universe surveys, because the desired information is collected from a sample of the population rather than the entire population. The main disadvantages in using sample surveys are that sampling design must be accounted for, small sample sizes may limit the power to find statistical differences (where they exist) for certain subgroups, and, because of sampling error, observed differences may not reflect actual differences in the population.

Examples of sample surveys at NCES are the Early Childhood Longitudinal Studies, the High School Longitudinal Study, and the National Postsecondary Student Aid Study.

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NCES studies are grounded in a scientific approach and designed to address specific research goals or questions within populations of interest. A sampling design is employed to obtain a representative sample of the populations of interest. This allows researchers to use smaller numbers of participants in studies while still maintaining validity, reliability, and accuracy.

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For any topic of interest, there are several methods for gathering data and options for choosing the respondents from whom to collect data. For example, if we are interested in finding out more about enrollment in postsecondary education, we could ask every high school graduate across the country if they enrolled in further education after high school. If we did that, we would be conducting a universe survey where we would gather data from all units in the population of interest. This effort would be resource-intensive, particularly because the population is very large and widely dispersed.

Alternatively, asking the students at 10 high schools in the DC area that we knew would participate would be a strategy to reduce our data collection resource burden. However, this would be a relatively small sample of convenience and would not have generalizability to the population of interest – all high school graduates. Questions may be raised about our rationale for selecting just 10 schools and why we chose those 10 schools in particular.

Ideally, we would ask students that are perfectly representative of the national population. That is precisely what NCES strives for in each of its sample surveys.

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NCES sample surveys are designed to ensure that the sample selected is representative of the population of interest, is sufficiently large to detect a difference of a prescribed magnitude with a predetermined level of precision, and includes subgroups of analytic interest in sufficient sizes to make reliable estimates about them. Sampling designs other than simple random samples also ensure that sampled units have known and non-equal chances of selection from the population of interest. Certain groups have different likelihood of selection. For example, if we are interested in selecting a representative sample of schools, we would need to select private schools at a different rate than public schools, because there are fewer private schools than public ones. These ideas will be explained in greater depth in the next few slides.

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The two types of sample designs are simple random samples, or SRSes, and complex samples.

Simple Random Samples are those in which every unit in the population has an equal probability of being selected for the sample. That probability is considered a non-zero probability.

Complex sample designs are those where every sampling unit has a known, but not equal, probability of being selected for the sample.

NCES uses three types of complex sample designs in its data collection: stratified, clustered, and multi-stage cluster designs.

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SRS is the most basic probability sampling design and is rarely used on its own in NCES surveys. It may be incorporated into more complex sampling designs. In a simple random sample, each sample member is selected independently of all the others.

SRS ensures that every unit in the population has an equal non-zero probability of being selected for the sample.

However, there are some drawbacks to this sample design. For example, SRS is not effective for studies from which small subgroups, like smaller racial groups, are to be included in the analysis. This is because even with a large sample, SRS cannot ensure that small subgroups within the population are adequately represented in the sample, since members of these subgroups may not be selected in sufficient enough numbers to accurately represent their proportions in the population.

In order to ensure that important smaller subgroups are included in the sample, oversampling techniques can be used. For example, small racial populations such as American Indians/Alaska Natives are often oversampled in order to have enough data to measure differences on key variables of interest in this subgroup.

In addition, SRS can be costly when population units are spread over a wide geographic area and in-person follow-up is needed.

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NCES uses complex sample designs to collect the most accurate data in a cost-efficient manner.

Stratification, clustering, and multi-stage sampling are techniques used to increase the efficiency in measuring specific subsamples in a population. Stratification is used to ensure that different subgroups are adequately represented in the sample. Stratification involves dividing the sampling frame into relevant subgroups prior to sample selection. Clustering involves the selection of groups of units, or clusters, such as schools within a district or students within schools. Multi-stage sampling involves multiple stages of sub-sampling, such as first selecting schools, then selecting students.

Whereas with SRS every unit in the population has an equal, non-zero probability of being selected for the sample, this is not the case with complex sample designs. In a complex sample, units of the population have a known, but not equal, probability of being selected for the sample.

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Stratification helps to increase accuracy when estimating population parameters for these subgroups by ensuring that different subgroups of a population are represented adequately in the sample.

Stratification divides the sampling frame into mutually exclusive homogenous strata, or groups, in such a way that sampling units within each stratum are more alike than units in the sampling frame as a whole on a specific dimension that is considered analytically important. For example, there might be one stratum for each racial group.

Every unit within a stratum has the same probability of being selected. Each stratum is then sampled independently. Units in the strata may be sampled in proportion to their size in the frame population, to insure that the sampled estimates reflect the distribution of the sampling frame.

In some instances, such as when analyses are to be calculated for very small subgroups, it may be advantageous to have units from a particular stratum over-represented in the sample. This is known as oversampling, or disproportionate sampling. It is achieved by drawing more sampling units from that stratum than would be sampled in a simple random sample. The effect of disproportionate sampling on the final estimate is then corrected through weighting.

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Clustering and multi-stage sampling can reduce the time and cost of data collection over wide geographic areas, such as the United States, when in person follow-up is anticipated.

Clustering involves selecting a sample of grouped sampling units. Each group is considered a cluster. Unlike strata, which are internally homogenous, clusters are designed to be internally heterogeneous because they must represent the clusters that are not selected.

For example, clusters of geographic areas within a state may be selected. If all the sampling units in the selected clusters are included in the sample, this method is known as one-stage cluster sampling. If, however, only a sample of units is taken from each selected cluster, this method is known as two-stage cluster sampling.

When more stages are involved, such as when students are sampled within schools that have been sampled within school districts, this is known as multi-stage cluster sampling. Multi-stage clustering proceeds as follows:

The first stage in multi-stage sampling involves selecting a sample of clusters. The second stage in multi-stage sampling involves selecting a sample of respondents from within the cluster or another sample of clusters. For example, in an education study, the first stage might be school districts, with a sample of schools within each selected school district as the second stage, a sample of teachers of specific classes as the third stage, and a sample of students within those teachers' classes as the fourth stage of a multi-stage cluster sample. Multi-stage cluster sampling, like clustering, can be employed to reduce the time and cost of data collection. Multi-stage cluster sampling can also be used to facilitate multilevel analysis of the relationships between the levels.

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As we have been learning, NCES datasets are derived from studies with complex sample designs. When using NCES datasets, appropriate sampling weights must be used to produce population-level estimates. Furthermore, due to the complex nature of the sample, the variance of estimates cannot be accurately calculated via standard SRS statistical methods. You must use a variance estimation technique that is appropriate for the complex sample designs used in NCES surveys.

NCES provides the sampling design information needed to use complex variance estimation software to compute estimates of variance that reflect the complex sample design of the data collection. If this information is not used, or if it is not used correctly, the results of hypothesis testing, or the p values, will be incorrect.

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Sampling weights are used to indicate the relative contribution of an observation. For example, if a student in a dataset is assigned a weight of 1050, this means that the student represents 1,050 students in the population who have the characteristics used in the sampling design, such as race or ethnicity and grade level.

The sampling weight is the inverse of the probability of a unit being selected into the sample. Remember that in complex sample designs, the selection probability of each unit is known, but not equal.

Weights account for sample selection procedures, meaning they adjust for the fact that not all units had an equal probability of selection into the sample. The weights can be adjusted for the fact that nonresponse may be greater among certain subgroups of the population. This adjustment is important because when there are differential patterns of nonresponse, the data can be biased, or not representative of either the population or subgroups of interest. If all sources of nonresponse bias are accurately captured in the nonresponse weight adjustments, the end result produces estimates that represent the target population.

It is important to remember that weighting the data alone, without accounting for the complex sample design, will result in many findings that are statistically significant due to the large weighted population estimates that are really population counts.

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NCES develops weights that must be used with NCES data to compute estimates of population parameters that reflect the sampling design. Each study dataset provides weights to be used with data from the study.

Weights for cross-sectional studies are used to make the sample data representative of a given population at one point in time, for example the population of children attending kindergarten through grade 12 in 2007. Some cross-sectional NCES studies have collected data about the same population over time. Those data, when properly weighted, can be used to investigate changes in the population. The groups of people included in each data collection of a cross-sectional study are different, so the data from each sample, or time point, must be weighted with a distinct cross-sectional weight.

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Weights for longitudinal studies can also be used to make the sample data representative of a given population at one point in time or to look at change over time. Unlike cross-sectional studies, longitudinal studies follow the same group of people over time. The weights are designed to make the data representative of the target population, or cohort, regardless of when the data were collected. NCES longitudinal studies provide weights that can be used to analyze data from one or more rounds of data collection.

More information about the weights available for each study is provided within the study-specific DLDT modules.

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Sampling weights must ALWAYS be used with data from complex samples to ensure that information collected from the sample of the population accurately represents the entire population to which you wish to generalize. One of the most common mistakes by researchers is to analyze data from a study that employed a complex sample design as if the data were collected from a simple random sample. Examples and simulations of how to apply weights are provided in the next module, Statistical Analysis of NCES Datasets Employing a Complex Sample Design, as well as within each of the survey-specific modules within this system.

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This module has provided you with information about the research methods and statistical techniques that NCES uses in its studies to ensure high-quality micro-level data by describing:

- NCES study designs
- Sampling designs and weights
- Analysis of NCES data

There are several important resources that have been provided throughout the module and they are summarized here along with the module's objectives for your reference.

You may now proceed to the next module in the series, or click the exit button to return to the landing page.